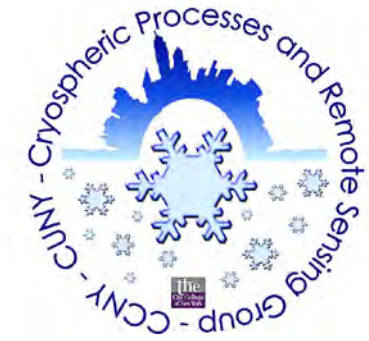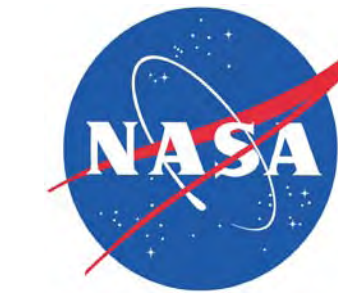# MAINTENANCE, VALIDATION AND IMPROVEMENT OF THE NASA AMSR-E SWE PRODUCT

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Maintenance:

The AMSR-E SWE product is currently maintained and distributed through the National Snow and Ice Data Center. Maintenance includes support for testing updates, for the distribution and questions arising from product's users. Also, it includes evaluating the effects on potential errors on brightness temperature on the final product. To this aim,two exact copies of the software generating the distributed product and relative configurations are fully operating at NASA Goddard Space Flight Center and at the City College of New York.
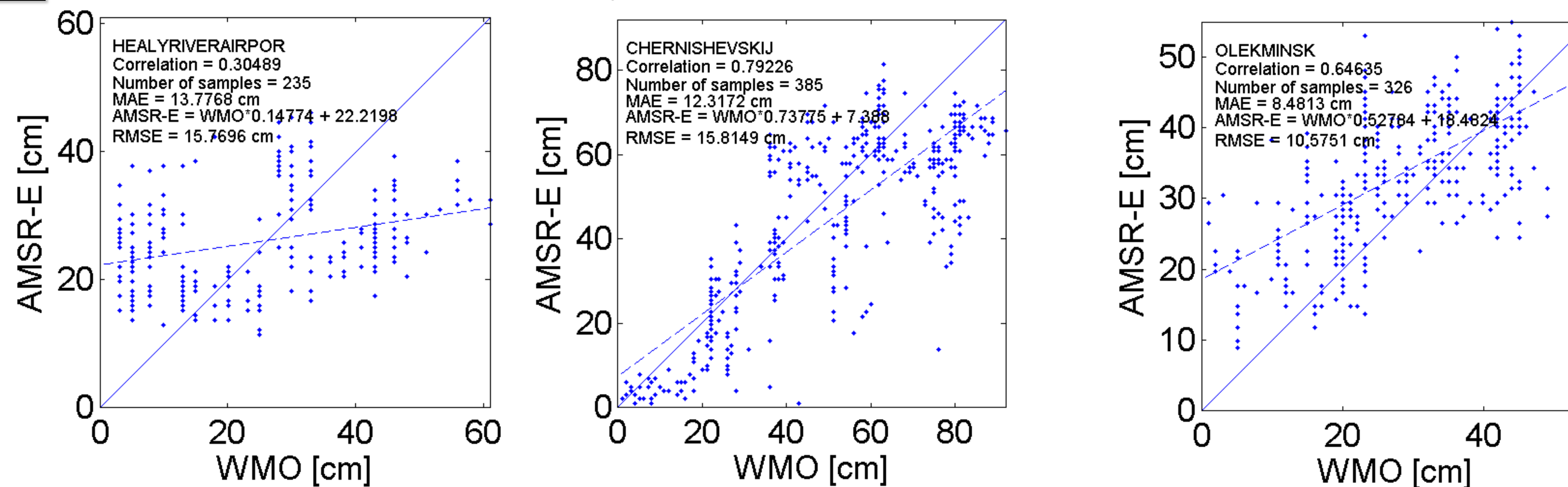
Validation:

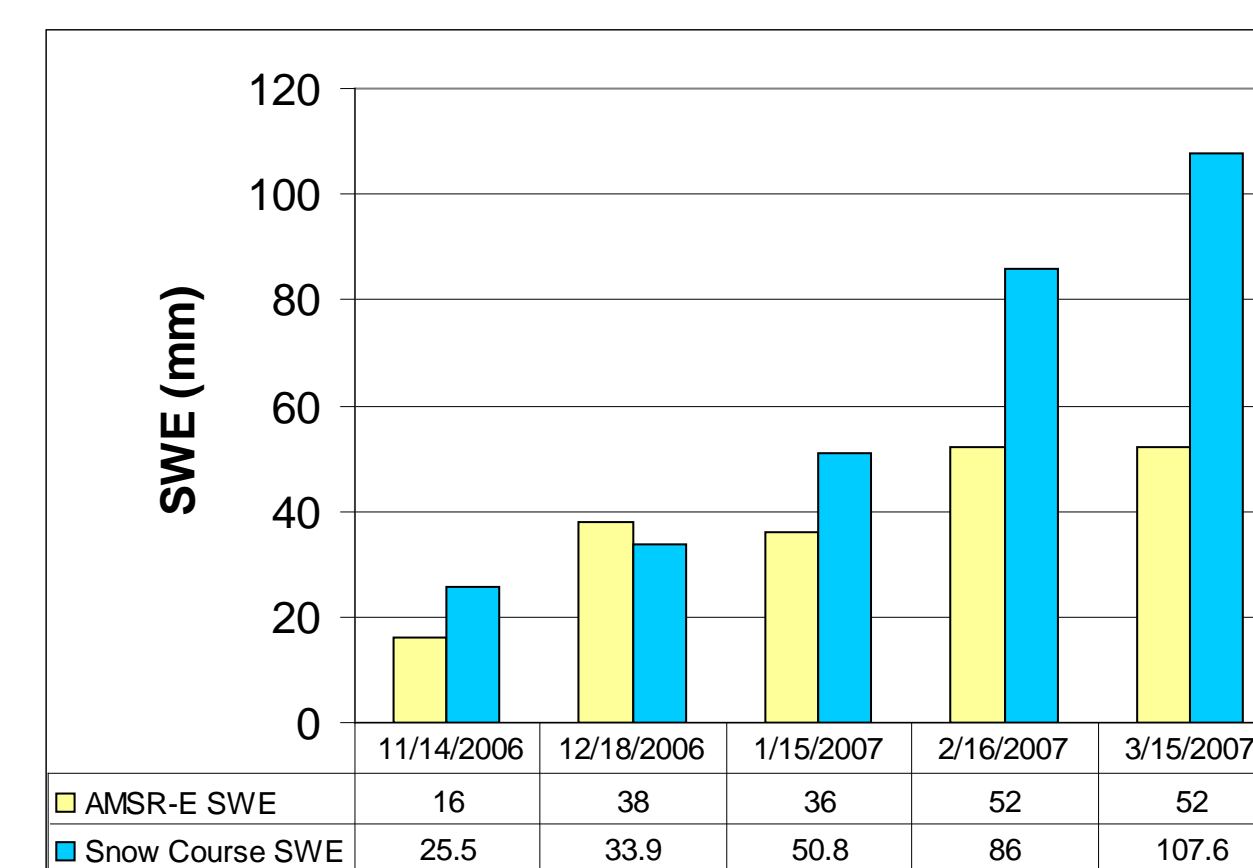Fig. 1 WMO vs. AMSR-E snow depth for selected stations

Because of the absence of SWE measurements on ground and the relative higher abundance of snow depth measurements, validation is reported for snow depth. Snow depth from AMSR-E is derived from the SWE values divided by the density of the corresponding EASE grid pixel. Density values range between 0.2040 and 0. 2645 g/cm3. As maximum SWE derived with the product is 480 mm, then the maximum snow depth (SDmax) ranges between 183.2 and 235.3 cm. Note that maximum penetration depth at microwave frequencies is of the order of 80 cm at 19 or 37 GHz. Nevertheless, higher snow depth values can be obtained either because of the use of the 10 GHz and because of the 'artificial' increase induced by the use of the forest fraction and density at the denominator of the formula for retrieving SD. The plots above show AMSR-E vs. WMO snow depth values for the different stations. Within each plot, the values of correlation coefficient between AMSR-E and WMO snow depth values are reported, together with the total number of samples used, the Root Mean Square Error (RMSE), the Mean Absolute Error (MAE), and the equation of the linear regression between AMSR-E and WMO values (dashed line). The 1:1 line is also reported as a reference (cont. line).

Fig. 2 AMSR-E Scandinavian SWE maps
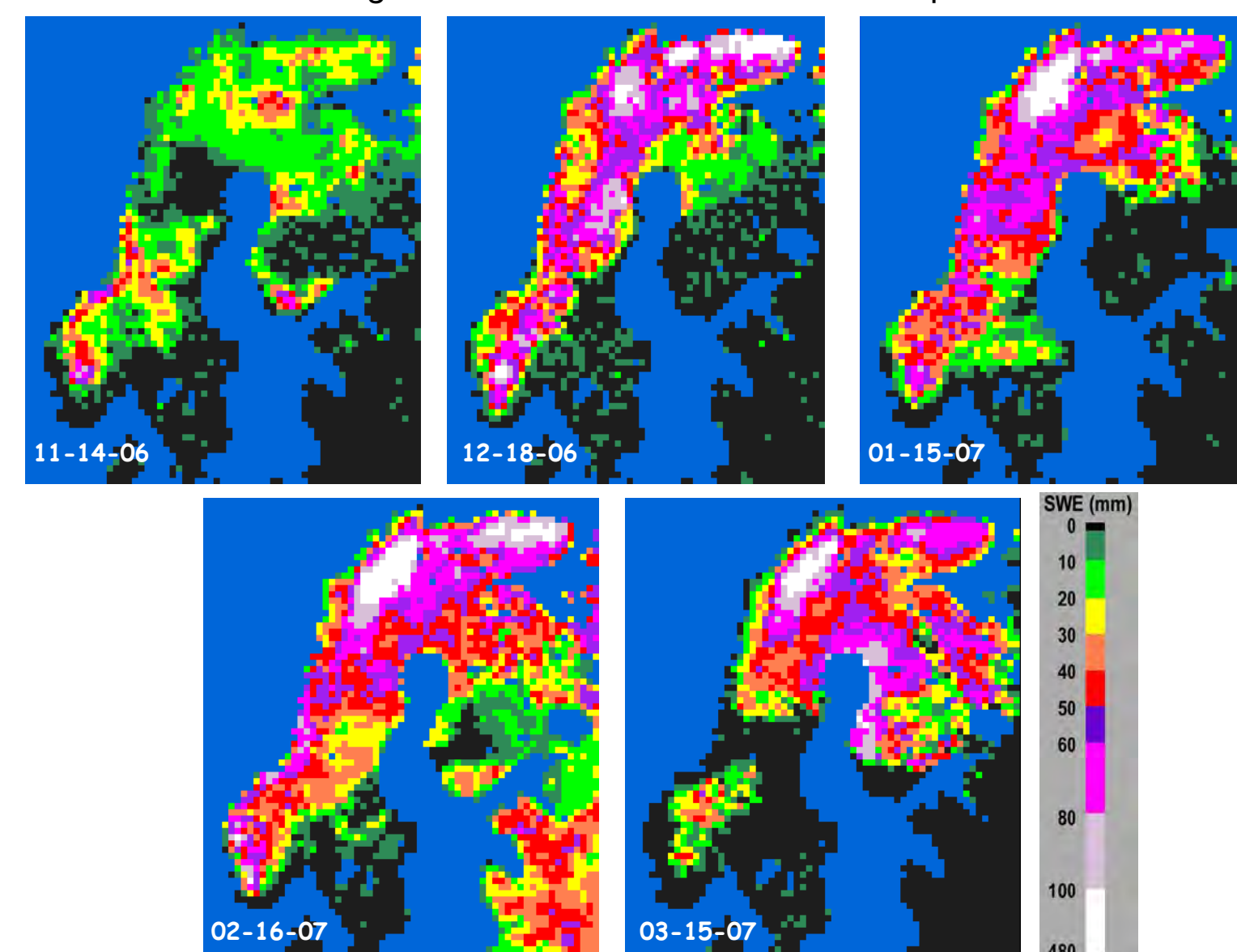
The comparison of AMSR-E derived SWE data corresponding with mid-month SWE snow course measurements at the Sodankylä Observatory are displayed in the AMSR-E Scandinavian SWE maps and the AMSR-E SWE / SYKE snow course SWE histogram plot. There is general agreement between the AMSR-E and snow course SWE measurements, with greater SWE measurement differences observed in February and March than the other months compared (November, December, January). Known AMSR-E SWE mapping issues that may explain the deviations include possible shallow snow cover, cold surfaces, or increased snow crystal grain size typical of the end of season snow.

Fig.3. Comparison between AMSR-E SWE and snow course SWE at Sodankylä

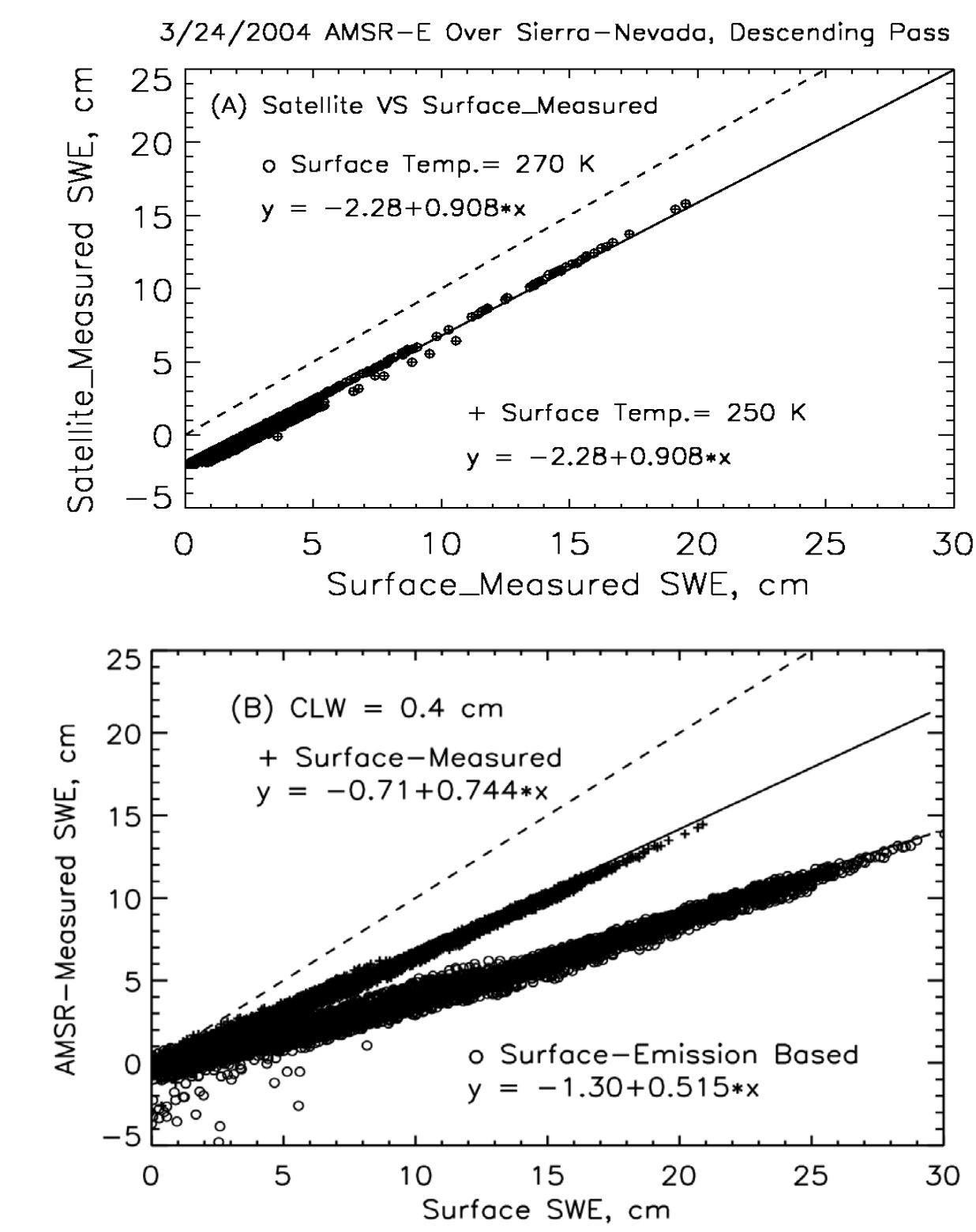|	11/14/2006	12/18/2006	1/15/2007	2/16/2007	3/15/2007
AMSR-E SWE	16	38	36	52	52
Snow Course SWE	25.5	33.9	50.8	86	107.6

Refinement:

Fig.4.AMSR-E SWE vs. surface SWE in the case of clear sky (top) and cloudy sky (bottom) over a Sierra Nevada test site

We modeled the effect of atmosphere on both 18.7 and 36.5 GHz brightness temperature and their difference, using radiosonde data and a multi-layer electromagnetic model. Results for a test site over the Sierra Nevada are reported in the figures beside. In particular, the top plot shows the satellite-measured vs. surface measured SWE in case of clear skies where the bottom plot shows the same but in the case of cloudy skies with cloud liquid water content of 0.4 cm. We observe that in both cases the presence of the atmosphere can be important, with cloudy strongly affecting the retrieval.
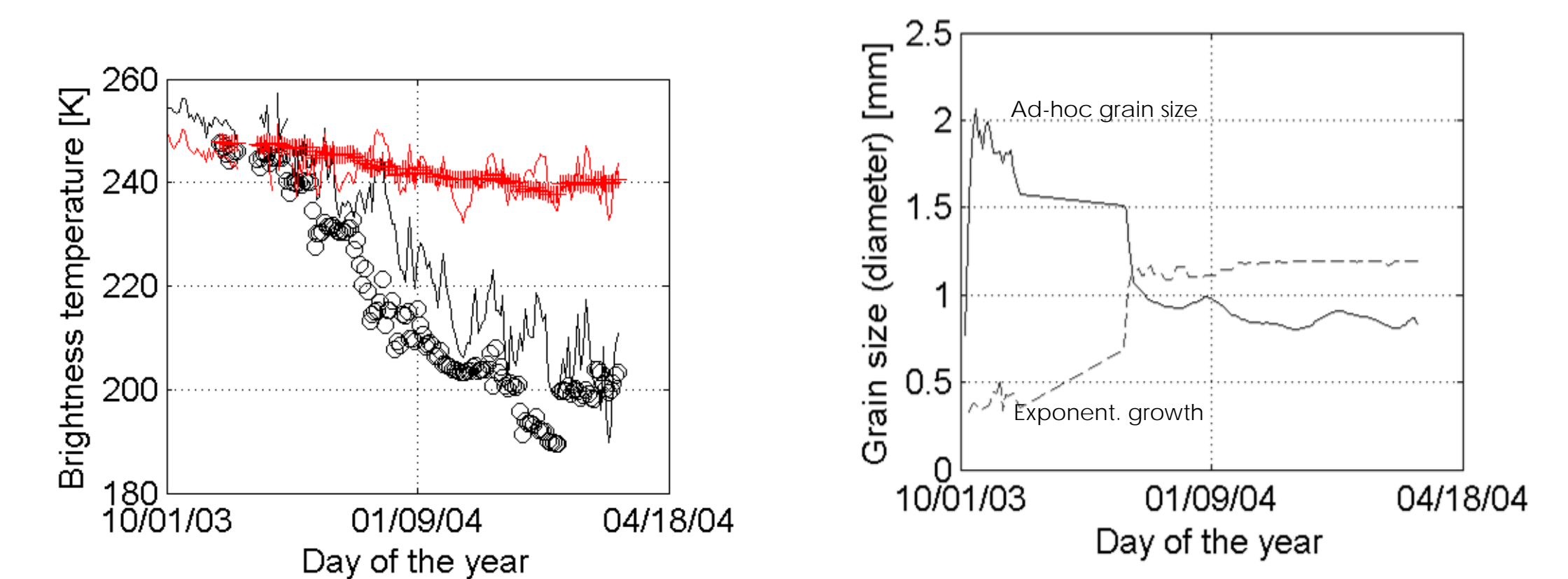

Fig. 5 Modeled (symbols) and measured (lines) brightness temperature at 18.7 (red) and 36.5 (black) GHz (left); optimum and modeled grain size for the brightness temperature in the left plot (right)

We also modeled AMSR-E brightness temperatures at 18.7 and 36.5 GHz using the HUT electromagnetic model, whose inputs are derived from simplified physically-based assumptions in which grain size evolves exponentially during the snow season. Snow depth was obtained from WMO station data. In general, we were able to model AMSR-E data to reproduce the seasonal behavior (see bottom left figure), although discrepancies between absolute modeled and measured values were observed. We investigated the effect of the evolution of the grain size along the snow season. To this aim, we compared the values of grain size used as inputs to the model with those obtained by fitting measured and modeled brightness temperatures. We observed that, depending on the case, the general assumption of exponential growth for grain size might be valid or not.

Conclusions:

Currently, the AMSR-E SWE product is maintained, validated and refined. Validation is undergoing by using more than 70 WMO stations data for the period 2002 – 2008, results from experiments (such as CLPX, GAME/CEOP) and other sensors (e.g., MODIS for SCA). Studies for refining the algorithm are undergoing by considering atmospheric effects and the evolution of grain size along the snow season. Ongoing work includes the combination of active and passive MW data and the use of complementary information, such as outputs from Land Models.